AMENDMENTS TO THE DRAWINGS

Please replace Formal Drawings Figures 3 and 4 with the attached Replacement Formal Drawings Figures 3 and 4 (A4; Figs. 3 and 4; 2 sheets).

REMARKS

Favorable reconsideration is respectfully requested in view of the foregoing amendments and the following remarks.

I. CLAIM STATUS & AMENDMENTS

Claims 1-11 were pending in this application when last examined.

Claims 5-11 were examined on the merits and stand rejected.

Claims 6 and 8 were objected to.

Claims 1-4 were withdrawn as non-elected subject matter.

Claims 1-4 have been cancelled without prejudice or disclaimer thereto. Applicants reserve the right to file a continuation or divisional application on any cancelled subject matter.

Support for the amendment to claims 5-11 can be found in the disclosure, for example, at page 6, lines 17-20, page 10, lines 1-2 and 14-15, page 11, and lines 3-5 and 13-14, and in original claims 5-11.

The Specification has been amended in the paragraph at page 11 at lines 15-19 along the lines suggested by the Examiner to correct a typographical error.

Enclosed herewith are replacement formal drawings for Figures 3 and 4, which have been labeled as Prior Art as requested by Office.

No new matter has been added by the above amendments.

Claims 5-11 are pending upon entry of this amendment.

II. INFORMATION DISCLOSURE STATEMENT

Attached herewith is a copy of JP 61-16230 B2 for official consideration by the Office. Applicants are in the process of preparing an English translation and/or English summary thereof and will submit such in the near future. Please officially consider the reference and return a PTO-1449 form indicating such.

III. OBJECTIONS TO THE DRAWINGS

In item 3 on page 3 of the Office Action, Figures 3 and 4 were objected to for lacking a legend, designating the drawings as prior art. Corrected replacement formal drawings with the appropriate label are submitted herewith to overcome this objection.

IV. OBJECTIONS TO THE SPECIFICATION

In item 5 on page 4 of the Office Action, the Specification was objected to at page 11, lines 15 and 17, on the basis that it is unclear what is meant by "JIS:SM570Q" and "JIS:YGW21." The Specification was also objected to for a typographical error at page 11, line 18.

These objections are respectfully traversed.

In reply thereto, enclosed herewith is an English translation of JIS (Japanese Industrial Standard) for the Office's consideration. JIS:SM570Q is disclosed in the English text of JIS G 3106. The chemical composition of SM570 is listed in Table 2 on page 3 of the text and "Q" means that quench-hardening and tempering is applied for steel of SM570. See page 8, c) in a head portion. JIS:YGW21 is disclosed in the English text of JIS Z 3312. The chemical composition of YGW21 is listed in Table 2 on page 2 of the text. These documents are evidence that one skilled in the art would clearly understand what is intended by "JIS:SM570Q" and "JIS:YGW21" as they are art recognized terms.

Also, the Specification has been amended at page 11, line 18 to replace "Mu" with "Mn" as suggested by the Office.

Therefore, the objections to the Specification are untenable and should be withdrawn.

V. CLAIM OBJECTIONS

In item 6 on page 4 of the Action, claims 6 and 8 were objected to. It is respectfully submitted that the present amendment overcomes these objections for reasons which are self-evident.

VI. REJECTION UNDER 35 U.S.C. § 112, SECOND PARAGRAPH

In item 8 on pages 4-5, claims 5-11 were rejected under 35 U.S.C. § 112, second paragraph, as indefinite for the reasons set forth therein.

It is respectfully submitted that the present amendment overcomes this rejection as the claims have been amended to clarify the invention.

The rejected term "for a welding method" has been deleted from the claims

In amended claim 5, the welding material used in the additional welding method is defined as a material at which martensite transformation expansion terminates at room temperature at or near the location where welding is complete. This definition is based on the description on page 6, lines 17-19.

Further, claim 5 has been amended to include omitted essential steps by clarifying the relationship of the initial step of welding prior to the additional welding step. In this regard, amended claim 5 defines that the additional welding method is performed to induce compressive residual stress near a weld zone by an initial welding prior to the additional welding step. This definition is based on the description on page 11, lines 13-14. The fact that an initial welding is performed prior to the additional welding method is clearly understood by the last two lines on page 10.

Furthermore, claim 5 has been amended to define "heat history" as alternation of heating and cooling during the additional welding as defined and used in the disclosure. For instance, this definition is clearly understood from the description disclosing the conventional additional welding on page 10, lines 14-15.

Claim 6 has been amended to clarify the relationship of the various component parts. More specifically, in amended claim 6, a welding mode is defined as supported by the disclosure. That is, a horizontal annex material is connected to a vertical member by welding. This welding mode is described on page 10, lines 1-2. Amended claim 6 also defines a process of the additional

welding method after connecting the horizontal member to the vertical member by welding. The process is described on page 11, lines 3-5.

Claim 7 has been amended along the lines suggested by the Examiner to replace the rejected language "may become" with more acceptable language.

It is respectfully submitted that the skilled artisan, upon reading the disclosure and in view of the knowledge in the art, would clearly understand the metes and bounds of the language of the amended claims. For this reason, the rejection of claims 5-12 under 35 U.S.C. § 112, second paragraph, is untenable and should be withdrawn.

VII. OBVIOUSNESS REJECTIONS

In items 11-12 on pages 6-8 of the Action, claims 5-8 were rejected under 35 U.S.C. § 103(a) as being obvious over JP 3010211 in view of JP 54-130451, and claims 9-11 were rejected under 35 U.S.C. § 103(a) as being obvious over JP 3010211 in view of JP 54-130451 and further in view of JP 59-85378.

These rejections are respectfully traversed as applied to the amended claims.

The amended claims call for an additional welding method using a welding material having a low transformation temperature, which terminates its martensite transformation expansion at room temperature at or near the location where welding is complete, wherein said additional welding method is performed to induce compressive residual stress near a weld zone by an initial welding prior to said additional welding without heat history that is alteration of heating and cooling during said additional welding.

It is respectfully submitted that the cited references fail to disclose or suggest each and every element of the claimed invention, namely (1) a welding material having a low transformation temperature, which terminates its martensite transformation expansion at room temperature at or near the location where welding is complete; and (2) wherein said additional welding method is performed to induce compressive residual stress near a weld zone by an initial welding prior to the

additional welding without heat history that is alteration of heating and cooling during said additional welding.

In this regard, as to the rejection in item 11, in the method of reducing residual stress at a welded joint of a steel workpiece disclosed in JP 54-130451, a final welding is performed with an austenitic metal, whereby the metal is cooled down at a temperature less than martensitic transformation. Transformation expansion during martensitic transformation of the metal cancels shrinkage of the deposited metal to reduce residual stress. The method disclosed in JP 54-130451 does not correspond to the additional welding of the present invention. In the present invention, the additional welding is performed near a weld zone by an initial welding prior to the additional welding without heat history that is alternation of heating and cooling during the additional welding. The additional welding near the weld zone without heat history that is alteration of heating and cooling during the additional welding is not disclosed or suggested by JP 54-130451.

In addition, the welding material having a low transition temperature is a material whose martensite transformation expansion terminates at room temperature at or near the location where welding is complete. The austenitic metal disclosed in JP 54-130451 transforms by cooling down at a temperature less than martensitic transformation, such as less than 60°C. Accordingly, the austenitic metal disclosed in JP 54-130451 is substantially different from the welding material having a low transition temperature used in the present invention.

Furthermore, the method disclosed in JP 54-130451 is a method of reducing residual stress at a welded joint. In contrast, in the present invention, the additional welding is performed to induce compressive residual stress near a weld zone by an initial welding prior to the additional welding. The induction of compressive residual stress near the weld zone enhances fatigue strength. See page 11, line 13. Thus, the technical concept and principle forming the basis of the present invention are quite different from the method disclosed in JP 54-130451. Consequently, the present invention is not suggested by the combination of JP 3010211 and JP 54-130451.

Additionally, in amended claim 6, the welding is performed in order to connect a horizontal annex to a vertical member. In contrast, in JP 3010211, welding is performed in order to connect a vertical annex material to a horizontal member and therefore it is possible to horizontally move a weld line for the connection. Hence, an advantage of the present invention in that it is unnecessary to swing a weld line right and left and weld cracks during the additional welding had not been recognized prior to the instant invention. In this regard, the problem of weld cracks during the additional welding had not been pointed out before connecting a horizontal annex to a vertical member by welding. Accordingly, JP 3010211 does not motivate the skilled artisan to solve the problem of such weld cracks during the additional welding as in the present invention.

For this reason, the cited references lack motivation/suggestion to combine/modify their teachings to arrive at the present invention with a reasonable expectation of success.

With regard to the rejection in item 12, although JP 59-85378 discloses a TIG welding method using only a rare gas as a shielding gas, the present invention is not suggested by the combination including JP 54-130451 as mentioned above. In addition, in claims 10 and 11, a mixture of a rare gas and oxygen is used as a shielding gas. This gas mixture is not disclosed or suggested by JP 3010211 or JP 59-85378. JP 3010211 discloses a rare gas including CO_2 but not including oxygen.

Therefore, the 103(a) obviousness rejections of claims 5-8 and 9-11 are untenable and should be withdrawn.

CONCLUSION

In view of the foregoing amendments and remarks, it is respectfully submitted that the present application is in condition for allowance and early notice to that effect is hereby requested.

If the Examiner has any comments or proposals for expediting prosecution, please contact the undersigned attorney at the telephone number below.

Respectfully submitted,

Akihiko OHTA et al.

By: _____

Jay F. Williams
Registration No. 48,036
for
Matthew M. Jacob
Registration No. 25,154
Attorneys for Applicants

MJ/JFW/mjw
Washington, D.C. 20006-1021
Telephone (202) 721-8200
Facsimile (202) 721-8250
March 16, 2007

ATTACHMENTS:

1. Submission of Formal Replacement Drawings (A4; Figs. 3 and 4; 2 sheets)
2. JP 61-16230 B2
3. Abstract (clean version)
4. English text of JIS G 3106 (Japanese Industrial Standard)
5. English text of JIS Z 3312 (Japanese Industrial Standard)

JIS

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS G 3106 : 2004

(JISF)

Rolled steels for welded structure

ICS 77.140.01

Reference number : JIS G 3106 : 2004 (E)

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee, as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Iron and Steel Federation (JISF) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS G 3106** : 1999 is replaced with this Standard.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Date of Establishment: 1952-11-25

Date of Revision: 2004-03-20

Date of Public Notice in Official Gazette: 2004-03-22

Investigated by: Japanese Industrial Standards Committee
Standards Board
Technical Committee on Iron and Steel

JIS G 3106:2004, First English edition published in 2004-06

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

Contents

Rolled steels for welded structure

Introduction This Standard is the Japanese Industrial Standard specified by making revisions on the text of the original Japanese Industrial Standard revised in 1999 such as the expansion of the scope of flats, and by specifying **ISO 630** *Structural steels—Plates, wide flats, bars, sections and profiles* published in 1995 as annex 2 without modifying the technical contents.

1 Scope This Standard specifies the hot rolled steels (hereafter referred to as "steel products") to be used for bridges, ships, rolling stocks, petroleum storage tanks, containers and other constructions that have superior weldability.

Remarks : In using this Standard, either its text or annex 2 shall be applied.

The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

ISO 630 : 1995 *Structural steels—Plates, wide flats, bars, sections and profiles* (MOD)

2 Normative references The standards listed in attached table 1 contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

3 Grade and designation The steel products shall be classified into 11 grades, and their designation shall be as given in table 1.

Table 1 Designation of grade

Designation of grade	Applicable thickness	mm
SM400A	Steel plate, steel strip in coil, section and flat	200 or under
SM400B		
SM400C	Steel plate, steel strip in coil and section Flat	100 or under 50 or under
SM490A	Steel plate, steel strip in coil, section and flat	200 or under
SM490B		
SM490C	Steel plate, steel strip in coil and section Flat	100 or under 50 or under
SM490YA	Steel plate, steel strip in coil, section and flat	100 or under
SM490YB		
SM520B	Steel plate, steel strip in coil, section and flat	100 or under
SM520C	Steel plate, steel strip in coil and section Flat	100 or under 40 or under
SM570	Steel plate, steel strip in coil and section Flat	100 or under 40 or under

Remarks 1 The steel plate which is until 150 mm in thickness of SM520B, SM520C and SM570 may be produced in accordance with agreement between the purchaser and supplier.

2 Flats up to 75 mm thick for SM400C and SM490C and up to 50 mm thick for SM520C may be produced in accordance with the agreement between the purchaser and supplier.

4 Chemical composition The steel products shall be tested in accordance with **10.1** and the ladle analysis value shall be in accordance with table 2.

Table 2 Chemical composition

Unit: %

Symbol of grade	C		Si	Mn	P	S
SM400A	50 mm or under in thickness	0.23 max.	—	2.5 × C min. (1)	0.035 max.	0.035 max.
	Over 50 mm up to and incl. 200 mm in thickness	0.25 max.				
SM400B	50 mm or under in thickness	0.20 max.	0.35 max.	0.60 to 1.40	0.035 max.	0.035 max.
	Over 50 mm up to and incl. 200 mm in thickness	0.22 max.				
SM400C	100 mm or under in thickness	0.18 max.	0.35 max.	1.40 max.	0.035 max.	0.035 max.
SM490A	50 mm or under in thickness	0.20 max.	0.55 max.	1.60 max.	0.035 max.	0.035 max.
	Over 50 mm up to and incl. 200 mm in thickness	0.22 max.				
SM490B	50 mm or under in thickness	0.18 max.	0.55 max.	1.60 max.	0.035 max.	0.035 max.
	Over 50 mm up to and incl. 200 mm in thickness	0.20 max.				
SM490C	100 mm or under in thickness	0.18 max.	0.55 max.	1.60 max.	0.035 max.	0.035 max.
SM490YA	100 mm or under in thickness	0.20 max.	0.55 max.	1.60 max.	0.035 max.	0.035 max.
SM490YB						
SM520B	100 mm or under in thickness	0.20 max.	0.55 max.	1.60 max.	0.035 max.	0.035 max.
SM520C						
SM570	100 mm or under in thickness	0.18 max.	0.55 max.	1.60 max.	0.035 max.	0.035 max.

Note (1) The value of carbon shall be applied the values of the actual ladle analysis.

Remarks 1 Alloying elements other than those given in table 2 may be added as necessary.

2 The chemical composition of the steel plate of which thickness is over 100 mm up to and including 150 mm in thickness of SM520B, SM520C and SM570 shall be in accordance with the agreement between the purchaser and the supplier.

5 Carbon equivalent or chemical composition on sensitivity of welding crack

5.1 Carbon equivalent or chemical composition on sensitivity of welding crack for SM570 The carbon equivalent or chemical composition on sensitivity of welding crack for SM570 shall be as follows:

Further, the carbon equivalent shall apply to quench-hardened and tempered steel products.

a) The carbon equivalent shall be calculated from the following formula by using the ladle analysis values of **10.1** and shall be in accordance with table 3.

$$\text{Carbon equivalent (\%)} = C + \frac{Mn}{6} + \frac{Si}{24} + \frac{Ni}{40} + \frac{Cr}{5} + \frac{Mo}{4} + \frac{V}{14} \quad \cdots\cdots (1)$$

Table 3 Carbon equivalent

Thickness of steel product mm	50 max.	Over 50 up to and incl. 100	Over 100
Carbon equivalent %	0.44 max.	0.47 max.	As agreed upon between the purchaser and supplier.

b) Chemical composition on sensitivity of welding crack may be applied instead of carbon equivalent subject to the agreement between the purchaser and supplier. In this case, the chemical composition on sensitivity of welding crack shall be calculated from the following formula by using the ladle analysis value of **10.1** and shall be in accordance with table 4.

Chemical composition on sensitivity of welding crack (%) =

$$C+\frac{Si}{30}+\frac{Mn}{20}+\frac{Cu}{20}+\frac{Ni}{60}+\frac{Cr}{20}+\frac{Mo}{15}+\frac{V}{10}+5B \quad \cdots\cdots\cdots\cdots \quad (2)$$

Table 4 Chemical composition on sensitivity of welding crack

Thickness of steel product mm	50 max.	Over 50 up to and incl. 100	Over 100
Chemical composition on sensitivity of welding %	0.28 max.	0.30 max.	As agreed upon between the purchaser and supplier.

5.2 Carbon equivalent or chemical composition on sensitivity of welding crack for thermomechanically controlled steel plate The carbon equivalent of the steel plate which is thermomechanically controlled processed under the agreement between the purchaser and supplier and the chemical composition on sensitivity of welding crack applied as substitute for the carbon equivalent under the agreement between the purchaser and supplier shall be as follows:

a) **The carbon equivalent** The carbon equivalent shall be calculated from the formula (1) of **5.1** by using the ladle analysis value of **10.1** and shall be in accordance with table 5.

Table 5 The carbon equivalent

Unit: %

Designation of grade		SM490A SM490YA SM490B SM490YB SM490C	SM520B SM520C
Applicable thickness	50 mm or under	0.38 max.	0.40 max.
	Over 50 mm up to and incl. 100 mm	0.40 max.	0.42 max.

Remarks : The carbon equivalent of the steel plate over 100 mm in applied thickness shall be in accordance with the agreement between the purchaser and the supplier.

b) **Weld cracking susceptibility of material** Weld cracking susceptibility of material shall be calculated from the formula (2) of **5.1** by using the ladle analysis value of **10.1** and shall be in accordance with table 6.

Table 6 The weld cracking susceptibility of material

Unit: %

Designation of grade		SM490A SM490YA SM490B SM490YB SM490C	SM520B SM520C
Applicable thickness	50 mm or under	0.24 max.	0.26 max.
	Over 50 mm up to and incl. 100 mm	0.26 max.	0.27 max.

Remarks : The weld cracking susceptibility of material of the steel plate over 100 mm in applied thickness shall be in accordance with the agreement between the purchaser and the supplier.

6 Mechanical property

6.1 Yield point or proof stress, tensile strength and elongation The steel products shall be tested in accordance with **10.2** and the yield point or proof stress, tensile strength and elongation shall be in accordance with table 7.

Table 7 Yield point or proof stress tensile strength and elongation

Designation of grade	Yield point or proof stress N/mm²						Tensile strength N/mm²		Elongation		
	Thickness of steel product(2) mm						Thickness of steel product(2) mm		Thickness of steel product(2) mm	Test piece	%
	16 or under	Over 16 up to and incl. 40	Over 40 up to and incl. 75	Over 75 up to and incl. 100	Over 100 up to and incl. 160	Over 160 up to and incl. 200	100 or under	Over 100 up to and incl. 200			
SM400A SM400B	245 min.	235 min.	215 min.	215 min.	205 min.	195 min.	400 to 510	400 to 510	5 or under	No. 5	23 min.
									Over 5 up to and incl. 16	No. 1A	18
SM400C					—	—			Over 16 up to and incl. 50	No. 1A	22
									Over 40	No. 4	24
SM490A SM490B	325 min.	315 min.	295 min.	295 min.	285 min.	275 min.	490 to 610	490 to 610	5 or under	No. 5	22
									Over 5 up to and incl. 16	No. 1A	17
SM490C					—	—			Over 16 up to and incl. 50	No. 1A	21
									Over 40	No. 4	23
SM490YA SM490YB	365 min.	355 min.	335 min.	325 min.	—	—	490 to 610	—	5 or under	No. 5	19
									Over 5 up to and incl. 16	No. 1A	15
									Over 16 up to and incl. 50	No. 1A	19
									Over 40	No. 4	21
SM520B SM520C	365 min.	355 min.	335 min.	325 min.	—	—	520 to 640	—	5 or under	No. 5	19
									Over 5 up to and incl. 16	No. 1A	15
									Over 16 up to and incl. 50	No. 1A	19
									Over 40	No. 4	21
SM570	460 min.	450 min.	430 min.	420 min.	—	—	570 to 720	—	16 or under	No. 5	19
									Over 16	No. 5	26
									Over 20	No. 4	20

Note (2) For sections, the term "thickness of steel product" means the thickness at the position where the test piece is taken as shown in annex 1 figure 1.

Remarks 1 For the elongation of No. 4 test piece of the steel products over 100 mm in thickness, 1 % is subtracted from the value of elongation given in table 7 per each increase of 25 mm in thickness or its fraction. However, the limit to be subtracted shall be 3 %.

2 The yield point or proof stress, tensile strength and elongation of the steel plate of over 100 mm up to and including 150 mm in thickness of SM520B, SM520C and SM570 shall be in accordance with the agreement between the purchaser and the supplier.

6.2 Charpy absorption energy The steel products over 12 mm in thickness shall be tested in accordance with **10.2** and the Charpy absorption energy shall be as given in table 8. The Charpy absorption energy in this case shall be expressed by the average of measured values of three test pieces and shall be judged by **9.6** of **JIS G 0404**.

Table 8 Charpy absorption energy

Designation of grade	Test temperature °C	Charpy absorption energy J	Test piece
SM400B	0	27 min.	V-notch test piece in rolling direction
SM400C	0	47 min.	
SM490B	0	27 min.	
SM490C	0	47 min.	
SM490YB	0	27 min.	
SM520B	0	27 min.	
SM520C	0	47 min.	
SM570	−5	47 min.	

7 Shape, dimension, mass and the tolerance thereon The shape, dimension, and mass of the steel products and the tolerance shall be in accordance with the following standards;

JIS G 3192, JIS G 3193, JIS G 3194

In this case, the width tolerances for the steel plate and cut-edged coil as well as the length tolerances for the steel plate shall be in accordance with the tolerance A in **JIS G 3193** unless particularly specified.

8 Appearance The appearance of the steel products shall be in accordance with clause **9** in **JIS G 3192**, clause **6** in **JIS G 3193** or clause **8** in **JIS G 3194**.

Further, the repair by welding of the steel plate of SM570 shall be previously agreed between the purchaser and the supplier.

9 Heat treatment and symbol

9.1 Heat treatment The steel products may be subjected to normalizing, quench-hardening and tempering, or tempering, as necessary. For all designations of grade, heat treatment such as thermomechanical control process may be applied under the agreement between the purchaser and the supplier.

9.2 Symbol of heat treatment When the steel products have been subjected to heat treatment, the symbol of heat treatment shall be as follows:

Further, in appending the symbol of heat treatment according to the following manner, the symbol shall additionally be written to the end of the symbol of grade given in table 1.

a) In the case where normalizing is applied for the steel products by agreement between the purchaser and manufacturer: N

b) In the case where tempering is applied for the steel products by agreement between the purchaser and manufacturer: T

c) In the case where quench-hardening and tempering is applied for the steel products: Q

d) In the case where thermomechanical control is applied for the steel products: TMC

e) In the case where appropriate heat treatment is applied for the steel products: By agreement

Example of symbols: SM 490 CN, SM 570 TMC

10 Tests

10.1 Chemical analysis Chemical analysis shall be as follows.

10.1.1 Generals requirements for chemical tests The chemical composition of the steel products shall be determined by ladle analysis, and general requirements for chemical analysis and the sampling method of specimen for analysis shall be as specified in clause 8 in **JIS G 0404**.

10.1.2 Analytical method The method for chemical analysis shall be in accordance with any one of the following standards:

JIS G 1211, JIS G 1212, JIS G 1213, JIS G 1214, JIS G 1215, JIS G 1216, JIS G 1217, JIS G 1218, JIS G 1219, JIS G 1221, JIS G 1227, JIS G 1238, JIS G 1253, JIS G 1256, JIS G 1257, JIS G 1258

10.2 Mechanical test

10.2.1 Test in general General requirements for mechanical testing shall be as specified in clause 9 of **JIS G 0404**. In this respect, the sampling method of specimen shall conform to class A, and number of test pieces and sampling positions shall be as follows:

a) **Number of tensile test pieces** The number of tensile test pieces shall be as follows:

   1) **Steel plate and flat** A test lot shall consist of the steel products, from one heat where the maximum thickness is within twice the minimum thickness, and one tensile test piece shall be taken therefrom. When the mass of one test lot, however, exceeds 50 t, two tensile test pieces shall be taken. With this respect, if a single steel plate exceeds 50 t, one test piece shall be taken from the said plate.

   2) **Steel strip in coil and cut-to-lengths** A test lot shall consist of the steel products, from one heat, rolled to the same thickness, and one tensile test piece shall be taken therefrom. When the mass of one test lot, however, exceeds 50 t, two tensile test pieces shall be taken.

3) **Steel section** A test lot shall consist of the steel products, from one heat, rolled to the same sectional profile group where the maximum thickness is within twice the minimum thickness, and one tensile test piece shall be taken therefrom. When the mass of one test lot, however, exceeds 50 t, two tensile test pieces shall be taken.

4) **Number of test pieces for heat treated steel products** The number of test pieces for the heat treated steel products, from the same heat, rolled to the same sectional profile group, subjected to heat treatment under the same treatment conditions, shall be determined in accordance with 1), 2) or 3) in this item.

b) **Number of impact test pieces** For the steel products that have not been heat treated, one specimen shall be taken from the maximum thickness product of a test lot, from one heat, rolled to the same sectional profile group. For the heat treated steel products, one specimen shall be taken from the maximum thickness product of a test lot, from one heat, rolled to the same sectional profile group, subjected to heat treatment under the same treatment conditions. Three test pieces shall be taken from each specimen parallel to the rolling direction.

c) **Sampling position of the tensile test piece** Sampling position of the tensile test piece shall be in accordance with **JIS G 0416**. However, annex 1 may be applied. Test pieces of steel strip in coil shall be sampled from the position adjacent to the material section to be evaluated.

d) **Sampling position of the impact test piece** Sampling position of the impact test piece shall be in accordance with **JIS G 0416**. For the thickness of 40 mm or less, annex A figure A.11 **a)** of **JIS G 0416** shall apply, and for the thickness of over 40 mm, annex A figure A.11 **b)** of **JIS G 0416** shall apply.

Annex 1 may be applied.

Test pieces of steel strip in coil shall be sampled from the position adjacent to the material section to be evaluated.

10.2.2 Test piece The tensile test piece and impact test piece shall be as follows:

a) No. 1A, No. 4 or No. 5 test piece specified in **JIS Z 2201**

b) The V-notch test piece specified in **JIS Z 2202**. In this case, the longitudinal direction of the notch of the test piece shall be perpendicular to the rolled surface.

10.2.3 Test method The methods for tensile test and impact test shall be as follows:

a) **JIS Z 2241**

b) **JIS Z 2242**

10.2.4 Tensile test in the case where tensile test piece having specified dimensions can not be taken In the case where it is infeasible to secure the test piece having specified dimensions, matters on execution of tensile testing, test result values or the like shall be agreed upon between the purchaser and supplier.

10.2.5 Omission of tensile test and impact test of steel coil The tensile test and impact test of the steel coil may be omitted when approved by the purchaser.

11 Inspection

11.1 Inspection The inspection shall be carried out as follows:

a) General requirements for inspection shall be as specified in **JIS G 0404**.

b) The chemical composition shall conform to the requirements specified in clause 4.

c) The carbon equivalent or chemical composition on sensitivity of welding crack shall conform to the requirements specified in clause 5.

d) The mechanical properties shall conform to the requirements specified in clause 6.

e) The shape, dimensions and mass shall conform to the requirements specified in clause 7.

f) The appearance shall conform to the requirements specified in clause 8.

g) The purchaser may specify the ultrasonic testing specified in **JIS G 0801** or **JIS G 0901** or the like in addition to the inspection items given in a) to f). In this case, the test method, acceptance criteria, etc. shall be agreed previously between the purchaser and manufacturer.

11.2 Reinspection The reinspection shall be as follows:

a) The steel products which have not passed the tensile test may be retested in accordance with **9.8** in **JIS G 0404** and then whether it is accepted or not may be determined.

b) The steel products which have failed in the impact test specified in **9.6** of **JIS G 0404** may be retested in accordance with **9.8** of **JIS G 004** and determined to be acceptable or not.

c) The steel products which have not passed the mechanical test, may be again subjected to the mechanical test after heat treatment or reheat treatment. Then, whether it is accepted or not may be determined.

12 Marking The steel products which have passed the inspection shall be marked on each piece or each bundle with the following items by a suitable method. However, a part of the items may be omitted subject to the agreement between the purchaser and supplier.

a) Symbol of grade (including the symbol which stands for symbol of heat treatment specified in **9.2**)

b) Heat number or inspection number

c) Dimensions

d) Quantity or mass of each bundle (for steel plate and coil)

e) Manufacturer's name or identifying brand

13 Report The test report shall be in accordance with clause **13** in **JIS G 0404**. In case required, the manufacturer shall submit the symbol 2.3 or 3.1.B specified in table 1 of **JIS G 0415** to the purchaser.

Where the provision of remarks 1 of table 2 is applied, the content of alloying elements added shall be noted in the test report.

Attached Table 1 Normative references

JIS G 0404	*Steel and steel products—General technical delivery requirements*
JIS G 0415	*Steel and steel products—Inspection documents*
JIS G 0416	*Steel and steel products—Location and preparation of samples and test pieces for mechanical testing*
JIS G 0801	*Ultrasonic examination of steel plates for pressure vessels*
JIS G 0901	*Classification of structural rolled steel plate and wide flat for building by ultrasonic test*
JIS G 1211	*Iron and steel—Methods for determination of carbon content*
JIS G 1212	*Iron and steel—Methods for determination of silicon content*
JIS G 1213	*Iron and steel—Methods for determination of manganese content*
JIS G 1214	*Iron and steel—Methods for determination of phosphorus content*
JIS G 1215	*Iron and steel—Methods for determination of sulfur content*
JIS G 1216	*Iron and steel—Methods for determination of nickel content*
JIS G 1217	*Methods for determination of chromium in iron and steel*
JIS G 1218	*Iron and steel—Methods for determination of molybdenum content*
JIS G 1219	*Iron and steel—Methods for determination of copper content*
JIS G 1221	*Iron and steel—Methods for determination of vanadium content*
JIS G 1227	*Iron and steel—Methods for determination of boron content*
JIS G 1238	*Steel and iron—Determination of chromium content—Potentiometric or visual titration method*
JIS G 1253	*Iron and steel—Method for spark discharge atomic emission spectrometric analysis*
JIS G 1256	*Iron and steel—Method for X-ray fluorescence spectrometric analysis*
JIS G 1257	*Iron and steel—Methods for atomic absorption spectrometric analysis*
JIS G 1258	*Iron and steel—Methods for inductively coupled plasma atomic emission spectrometry*
JIS G 3192	*Dimensions, mass and permissible variations of hot rolled steel sections*
JIS G 3193	*Dimensions, mass and permissible variations of hot rolled steel plates, sheets and strip*
JIS G 3194	*Dimensions, mass and permissible variations of hot rolled flat steel*
JIS Z 2201	*Test pieces for tensile test for metallic materials*
JIS Z 2202	*Test pieces for impact test for metallic materials*
JIS Z 2241	*Method of tensile test for metallic materials*
JIS Z 2242	*Method of impact test for metallic materials*

Annex 1 (normative)
Sampling position of the test piece

1 Scope This annex specifies the sampling position of the test piece for tensile tests and impact tests.

2 Applicable date This annex applies until Dec. 31, 2008.

3 Sampling position of the test piece for tensile tests Sampling position of the test piece for tensile tests shall be as follows:

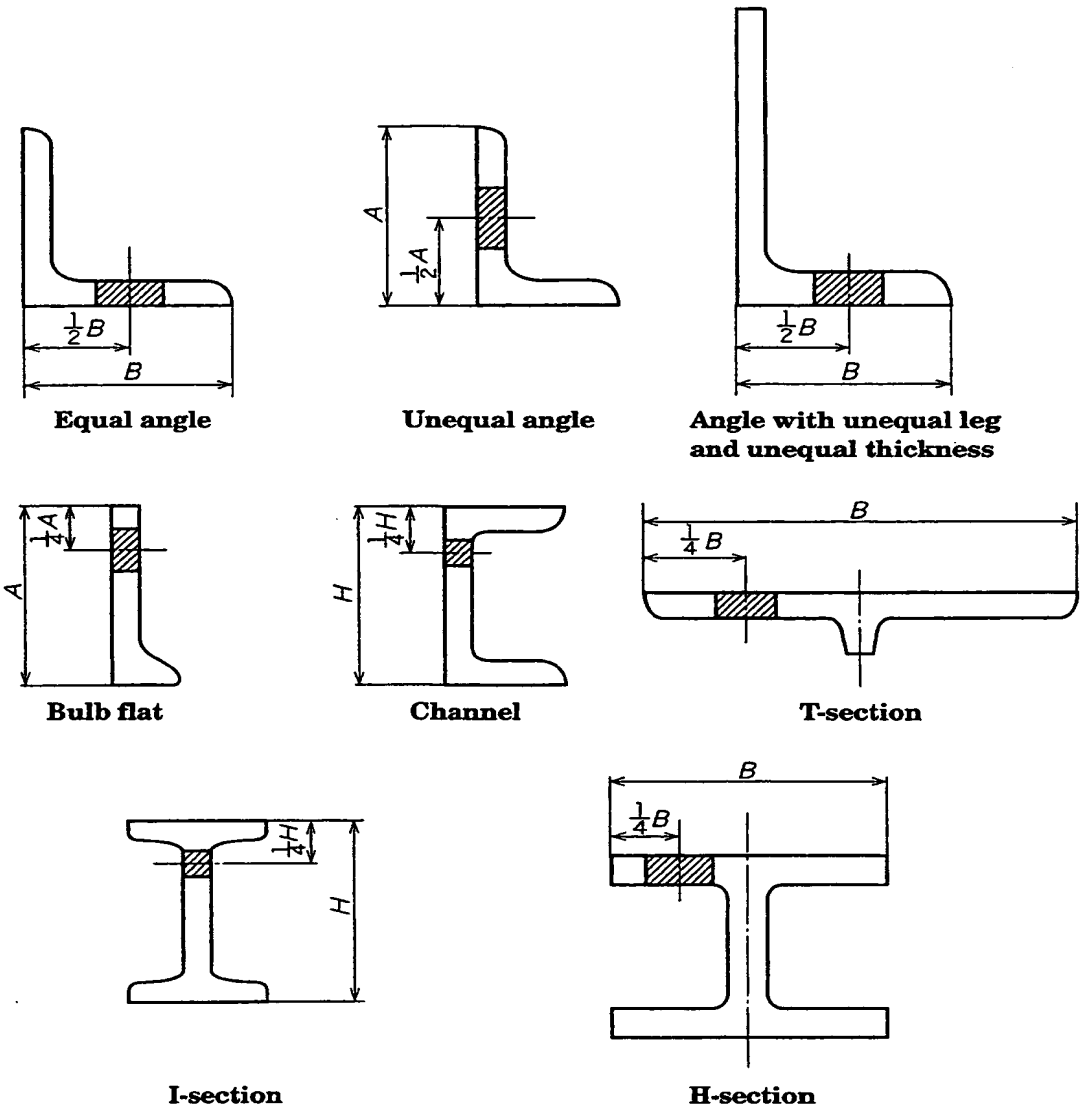
a) **Steel plate, steel strip in coil and flat** The centre of the test piece shall be at a quarter-width position from a side edge, and further in the case of No. 4 test piece, it shall be at a quarter-thickness position from a surface as well as a quarter-width position from a side edge. When it is infeasible to allow the centre of the test piece to be at a quarter-width position from a side edge or at a quarter-thickness position from a surface, however, the sampling should be performed as close to the aforementioned position as possible.

b) **Steel section** The sampling position shall be as shown in annex 1 figure 1. When it is infeasible to take a specimen as shown in annex 1 figure 1, the sampling position should be as close to the aforementioned position as possible. In the case of the steel H section from which a specimen is unable to take in the same manner as shown in annex 1 figure 1, the sampling position for the I section should be applied mutatis mutandis. For other steel sections, it should be agreed between the purchaser and the supplier.

4 Sampling position of the test piece for impact tests Sampling position of the test piece for impact tests shall as follows:

a) **Steel plate, steel strip in coil and flat** The centre of the test piece shall be at a quarter-thickness position from a surface, and it shall be at a quarter-width position from a side edge as well as a quarter-thickness position from a surface. When it is infeasible to allow the centre of the test piece to be at a quarter-thickness position from a surface and at a quarter-width position from a side edge, however, the sampling should be performed as close to the aforementioned position as possible.

b) **Steel section** The centre of the test piece shall be at a quarter-thickness position from a surface (see annex 1 figure 1). When it is infeasible to allow the centre of the test piece to be at a quarter-thickness position from a surface, however, the sampling should be performed as close to the aforementioned position as possible. In the case of the steel H section from which a specimen is unable to take in the same manner as shown in annex 1 figure 1, the sampling position for the I section should be applied mutatis mutandis. For other steel sections, it should be agreed between the purchaser and the supplier.



Annex 1 Figure 1 Sampling position of the test piece for tensile tests and bend tests for steel section

Annex 2 (normative)

Structural steels—Plates, wide flats, bars, section and profiles

Introduction This annex is the Japanese Industrial Standard prepared based on **ISO 630** *Structural steels—Plates, wide flats, bars, sections and profiles* published in 1995 as the second edition without modifying its technical content.

In this annex, the portions underlined with dot line are the matters added in the original International Standard.

Furthermore, the following annexes are contained in this annexes.

Annex A (normative)	Position and Orientation of test pieces
Annex B (normative)	Energy Values for impact test pieces of reduced size
Annex C (informative)	List of International Standards on tolerances for steel products
Annex D (informative)	Notes on weldability

1 Scope This annex specifies qualities for the general purpose structural steels listed in table 1 of the body. This annex applies to steel plates with thicknesses of 3 mm or over, wide strip in coils with widths 600 mm or over, and more than 6 mm in thickness, wide flats, bars and hot-refold sections generally used in the as-delivered condition and normally intended for bolted, riveted or welded structures(1).

It does not include the following steels, certain of which are covered by other International Standards:

— steels for boilers and pressure vessels (**ISO 9328-2**);

— plates of drawing quality (**ISO 3573** and **ISO 3574**);

— heat-treated (quenched and tempered) structural steels;

— bars for the reinforcement of concrete;

— strip of width 600 mm or over and thickness not exceeding 6 mm (**ISO 4955**).

Note (1) For precautions to be taken when welding, the guide for the welding and weldability of C-Mn and C-Mn micro-alloy steels published by Sub-commission IX-G of the International Welding Institute (document ISS/I IWI 843-87), together with the notes given in annex D should be referred to.

In particular, for the grade E 355, it should be noted that **ISO 4950-2** specifies an equivalent grade with better welding characteristics.

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of **IEC** and **ISO** maintain registers of currently valid International Standards.

ISO 148 : 1983 *Steel—Charpy impact test (V-notch)*

ISO 377-1 : 1989 *Selection and preparation of samples and test pieces of wrought steels—Part 1 : Samples and test pieces for mechanical test*

This Standard has been revised as **ISO 377** : 1997.

Information : **JIS G 0416** *Steel and steel products—Location and preparation of samples and test pieces for mechanical testing* is identical with the said standard.

ISO 377-2 : 1989 *Selection and preparation of samples and test pieces of wrought steels—Part 2 : Samples for the determination of the chemical composition*

This Standard has been revised as **ISO 14284** : 1996.

Information : **JIS G 0417** *Steel and iron—Sampling and preparation of samples for the determination of chemical composition* is identical with the said standard.

ISO 404 : 1992 *Steel and steel products—General technical delivery requirements*

ISO 2566-1 : 1984 *Steel—Conversion of elongation values—Part 1 : Carbon and low alloy steels*

ISO 3573 : 1986 *Hot-rolled carbon steel sheet of commercial and drawing qualities*

ISO 3574 : 1986 *Cold-reduced carbon steel sheet of commercial and drawing*

ISO 4948-1 : 1982 *Steels—Classification—Part 1 : Classification of steels into unalloyed and alloy steels based on chemical composition*

ISO 4950-2 : 1995 *High yield strength flat steel products—Part 2 : Products supplied in the normalized or controlled rolled condition*

ISO 4955 : 1994 *Heat-resisting steels and alloys*

ISO 4995 : 1993 *Hot-rolled steel sheet of structural quality*

ISO 6892 : 1984 *Metallic materials—Tensile testing*

ISO 6929 : 1987 *Steel products—Definitions and classification*

ISO 7788 : 1985 *Steel—Surface finish of hot-rolled plates and wide flats—Delivery requirements*

ISO 9328-2 : 1991 *Steel plates and strips for pressure purposes—Technical delivery conditions—Part 2 : Unalloyed and low-alloyed steels with specified room temperature and elevated temperature properties*

ISO 10474 : 1991 *Steel and steel products—Inspection documents*

Information : **JIS G 0415** *Steel and steel products—Inspection documents* is identical with the said standard.

3 Definitions Definitions of the terms "plate", "wide strip", "narrow strip" and "wide flat" are given in **ISO 6929**.

4 General requirements

4.1 Steelmaking process Unless otherwise agreed at the time of enquiry and order, the steel marking process is left to the discretion of the manufacturer: except for quality 0, the purchaser shall be informed of the process at the time of delivery.

4.2 Delivery condition

4.2.1 The products are generally delivered in the as-rolled condition. Other delivery conditions may form the subject of agreement when ordering.

4.2.2 Flat products of quality D may be ordered in two categories.

— Quality D1: It shall be delivered in the normalized or equivalent condition. The mechanical properties given in annex 2 table 3 are applicable in both the delivered condition and after normalizing by separate heat treatment after delivery.

— Quality D2: The mechanical properties given in annex 2 table 3 are only applicable in the delivery condition. The delivery condition is left to the discretion of the manufacturer.

4.3 Surface appearance—Defects

4.3.1 Surface appearance The products shall have a smooth surface corresponding to the rolling method used; they shall have to defects that are prejudicial to their subsequent processing or appropriate use.

4.3.2 Flat products The requirements of **ISO 7788** shall apply.

4.3.3 Long products

a) Minor defects may be removed by the manufacturer with grinding, provided that the thickness stays within the lower tolerance limits specified in the appropriate International Standards (refer to list in annex C) or, in the absence of International Standards, is not reduced locally by more than 6 % in relation to its nominal value.

b) Unless otherwise specified in the order, imperfections that are greater in depth than the limit specified in **a)** may be removed and deposited by welding subject to the following conditions.

   — The reduction of thickness of the material, resulting from removal of imperfections prior to welding, shall not exceed 2 % of the nominal thickness at the location of the imperfection.

   — All welding shall be performed by competent welders, using welding electrodes appropriate for the grade being repaired and following welding procedures approved by the purchaser.

5 Characteristics of grades and qualities

5.1 Chemical composition The steels specified are carbon steels in accordance with **ISO 4948-1**.

5.1.1 Ladle analysis The maximum values of the composition limits for ladle analysis are given in annex 2 table 1.

5.1.2 Product analysis Annex 2 table 2 gives the permitted deviations on analysis relative to the values for ladle analysis which are given in annex 2 table 1.

5.2 Mechanical properties The steels, in the delivery condition defined in **4.2**: shall comply with the mechanical properties specified in annex 2 table 3 when these are determined on test pieces prepared in accordance with **6.4**.

For products over 200 mm in thickness, the mechanical properties shall be the subject of an agreement between the purchaser and the supplier.

6 Inspection and testing

6.1 General Rolled products covered by this annex may be the subject of an inspection and testing in accordance with the conditions specified in **8.3** of **ISO 404** : 1992, relating to the mechanical properties and chemical analysis of the product. However, grade E 185 is only supplied with non-specific inspection and testing. Verification of chemical composition on the product and of the impact energy values at ambient temperature is only carried out by agreement at the time of enquiry and order. If an inspection and testing has been specified in the order, it shall be carried out in accordance with **6.2** to **6.5**, unless otherwise agreed when ordering.

6.2 Test unit Batching shall be by cast.

6.2.1 The test unit shall be 50 t or its fraction taken from one cast.

6.2.2 For each test unit and thickness range, as defined in annex 2 table 3, the series of the following tests shall be carried out.

— one tensile test [or additional test, in accordance with **6.2.4 a)** for products of thickness 16 mm or under];

— one set of three impact tests at 0 °C for quality C and one set of three test at −20 °C for quality D:

If specified on the order,

— one product analysis;

— one set of three impact tests at +20 °C for quality B.

6.2.3 The purchaser or his representative may witness the selection of the product sample from which the samples shall be taken for the verification of properties (refer to **ISO 404**).

6.2.4 Unless otherwise agreed by the purchaser, the procedure shall be as follows.

a) **Tensile test** One test sample shall be taken for each thickness range given in annex 2 table 3, with a supplementary requirement that, for the thickness 16 mm or under, the thickness of products shall be such that the maximum thickness is not greater than twice the minimum thickness.

Annex 2 Table 1 Chemical composition (ladle analysis)

Grade	Quality	Thickness *e* mm	Method of deoxidation (2)	C % max.	Si % max.	Mn % max.	P % max.	S % max.
E 185 (Fe 310)	0							
E 235	A		—	0.22	—	—	0.050	0.050
(Fe 360)	B	16 or under	—	0.17	0.40	1.40	0.045	0.045
		Over 16 up to and incl. 25	—	0.20	0.40	1.40	0.045	0.045
		40 or under	NE	0.17	0.40	1.40	0.045	0.045
		Over 40	NE	0.20	0.40	1.40	0.045	0.045
	C		NE	0.17	0.40	1.40	0.040	0.040
	D		GF	0.17	0.40	1.40	0.035	0.035
E 275	A		—	0.24	—	—	0.050	0.050
(Fe 430)	B	40 or under	NE	0.21	0.40	1.50	0.045	0.045
		Over 40	NE	0.22	0.40	1.50	0.045	0.045
	C		NE	0.20	0.40	1.50	0.040	0.040
	D		GF	0.20	0.40	1.50	0.035	0.035
E 355	C	30 or under	NE	0.20	0.55	1.60	0.040	0.040
(Fe 510)		Over 30	NE	0.22	0.55	1.60	0.040	0.040
	D	30 or under	GF	0.20	0.55	1.60	0.035	0.035
		Over 30	GF	0.22	0.55	1.60	0.035	0.035

Note (2) NE = Non-rimming

GF = These steels shall have a sufficiently high content of elements to produce a fine-grained structure (for example total Al 0.02 % or over).

Information : The letters shown in ( ) are the former designation of the steel products.

Annex 2 Table 2 Permissible deviation for the product analysis relative to the specified ladle analysis [refer to 6.4.3 a)]

Element	Specified limits %	Permissible deviation %
C	0.24 or under	+0.03
Si	0.55 or under	+0.05
Mn	1.60 or under	+0.10
P	0.050 or under	+0.010
S	0.050 or under	+0.010

Annex 2 Table 3 Mechanical properties

Grade	Quality	Yield point R_{eH} min. N/mm²							Tensile strength Rm (3) N/mm²	Elongation A min. ($L_0 = 5.65\sqrt{S_0}$) %					Impact test (V-notch), KV	
		Thickness mm								Thickness mm						
		16 or under	Over 16 up to and incl. 40	Over 40 up to and incl. 63	Over 63 up to and incl. 80	Over 80 up to and incl. 100	Over 100 up to and incl. 150	Over 150 up to and incl. 200		16 or under	Over 40 up to and incl. 63 (4)	Over 63 up to and incl. 100 (4)	Over 100 up to and incl. 150 (4)	Over 150 up to and incl. 200 (4)	Test temperature °C	Energy min.(5) J
E 185(6) (Fe 310)	0	185	175	—	—	—	—	—	300 to 540	18	—	—	—	—	—	—
E 235 (Fe 360)	A	235	225	215	215	215	195	185	340 to 470	26	25	24	22	21	—	—
	B(6)	235	225	—	—	—	—	—	340 to 470	26	—	—	—	—	—	—
	B NE	235	225	215	215	215	195	185	340 to 470	26	25	24	22	21	+20	27
	C	235	225	215	215	215	195	185	340 to 470	26	25	24	22	21	0	27
	D	235	225	215	215	215	195	185	340 to 470 (7)	26	25	24	22	21	-20	27
E 275 (Fe 430)	A	275	265	255	245	235	225	215	410 to 540	22	21	20	18	17	—	—
	B	275	265	255	245	235	225	215	410 to 540	22	21	20	18	17	+20	27
	C	275	265	255	245	235	225	215	410 to 540	22	21	20	18	17	0	27
	D	275	265	255	245	235	225	215	410 to 540 (7)	22	21	20	18	17	-20	27
E 355 (Fe 510)	C	355	345	335	325	315	295	285	490 to 640	22	21	20	18	17	0	27
	D	355	345	335	325	315	295	285	490 to 640 (7)	22	21	20	18	17	-20	27

Remarks : R_{eH} = upper yield stress
Rm = tensile strength
A = percentage elongation after fracture %
L_0 = gauge length on test piece
S_0 = original cross-sectional area of gauge length
1 N/mm² = MPa

Notes (3) For the tensile strength of wide strip only the minimum value of the range is applicable.

(4) For transverse test pieces (plates and wide flats of width 600 mm or over), these values are reduced by two points.

(5) Average of three tests; no individual result shall be less than 70 % of the specified minimum average value.

(6) This quality B is only delivered in thickness less than 25 mm.

(7) For over 100 mm in thickness, the lower limit of the range may be reduced 20 N/mm².

b) **Impact test** One test sample shall be taken for each thickness range specified in annex 2 table 3. For flat products of quality D, if agreed at the time of enquiry and order, a test sample shall be taken from each rolled product (parent plate or coil).

6.3 Position and orientation of test sample (refer to ISO 377 and ISO 14284)

6.3.1 Plates, wide steel strip in coil and wide flats of width 600 mm or over The test samples shall be taken a quarter-width from a side edge.

a) The longitudinal axes of tensile test piece shall be perpendicular to the direction of rolling.

b) The longitudinal axes of impact test piece shall always be parallel to the direction of rolling.

6.3.2 Sections, girders and wide flats of width less than 600 mm The longitudinal axes of the test pieces shall be parallel to the direction of rolling. However, if agreed, transverse test piece may be used for widths between 450 mm and 600 mm.

For sections, the test samples shall be taken such that the axis of the test piece is 1/3 from the outer edge of the half-flange (refer to H and U sections, **ISO 6929**) or of the flange (for other sections) or, for the small sections, as near as possible to this position (refer to annex A figure A.1). For the tapered-flange, sections, the test samples may be taken at the outer 1/4 position of the web.

6.3.3 Rounds, squares, flat bars, hexagons and other similar products The longitudinal axes of test pieces shall be parallel to the direction of rolling.

For small sizes, the product itself shall be taken as a test piece.

In other cases, the test piece shall be taken the axis of the test piece so as to be the following position.

— for squares and flat bars, at 1/6 of the width (from the outer face) or of the diagonal.

— for rounds and hexagons, at 1/6 from the outside of the diagonal or the diameter (refer to annex A figure A.1).

6.4 Test methods—Types of test pieces

6.4.1 Tensile test (refer to ISO 6892) Normally, the test piece used shall be plate type or rod type of proportional shape and have an original gauge length L_0 given by the formula,

$$L_0 = 5.65\sqrt{S_0}$$

where S_0 is the cross-sectional area of the gauge length of the test piece

The test piece of plate type with rectangular cross-section shall have a maximum width on the gauge length portion of 40 mm, and its thickness shall be that of the product: however, if the product thickness exceeds 30 mm, it may be reduced to 30 mm by planing or milling on one face only.

A test piece of rod type may be used for products more than 40 mm thick; it shall be 10 mm to 30 mm in diameter and its original gauge length shall be determined by the above formula; the axis of the test piece shall be positioned at 1/4 of the thickness of the product.

A non-proportional test piece with a fixed initial gauge length may be used.

In this case, reference shall be made to a conversion table (refer to **ISO 2566-1**). However, in case of dispute, only the results obtained on a proportional test piece shall be taken into consideration.

The yield stress specified in annex 2 table 3 of this Standard is the upper yield stress ReH, if the yield phenomenon is not visible, either the 0.2 % proof stress ($Rp_{0.2}$) or the 0.5 % proof stress (total elongation) ($Rt_{0.5}$) may be used. The specification of the material is complied with in this respect if one or other of these values satisfies the specified yield stress value.

6.4.2 Impact test

a) The impact test shall normally be carried out on products having a thickness more than 12 mm or diameter more than 16 mm. The test piece shall be machined so that the face nearest to the rolled surface is not more than 1 mm from it.

For products of thickness greater than 40 mm, the test piece shall be taken in such a way that its axis is positioned at 1/4 of the thickness from the surface.

The notch shall be perpendicular to the rolled surface. If agreed at the time of ordering, impact tests may be carried out on products having a thickness less than 12 mm: the dimensions of the test pieces shall be in accordance with the requirements of **ISO 148**, i.e. 10 mm × 7.5 mm and 10 mm × 5 mm, or shall correspond to 10 × e (e: being the product thickness). The specified energy values are given in annex B.

b) The test shall be carried out using a V-notch test piece supported at both ends (refer to **ISO 148**), the value to be taken into account being the average of the results obtained from three test pieces cut adjacent to each other from the same product, unless there are reasons for a retest (refer to **6.4.5**).

6.4.3 Chemical analysis

a) If a products analysis is specified on the order, the number of samples to be taken shall be in accordance with agreement between the purchaser and the supplier.

The samples may be taken from the test pieces used to check the mechanical properties or from the full thickness of the product at the same place as the test pieces. In case of dispute, only the analysis of material from the full thickness of the product shall be taken into consideration.

For the selection and preparation of samples for chemical analysis, the requirements of **ISO 14284** shall be applied.

b) In case of dispute, the method used for chemical analysis shall be in accordance with the requirements specified in the corresponding International Standard. If an International Standard does not exist, the method to be used shall be agreed between the parties concerned.

6.4.4 Faulty test and defective test pieces When a test does not give the required results because of an error in carrying out the test, it shall be cancelled. Error in carrying out the test means incorrect machining, incorrect mounting in the testing machine, malfunction of this machine or any other anomaly independent of the metal itself.

If a defective test piece gives satisfactory results, the batch shall be accepted but the corresponding item (from which the test sample was taken) may be subjected to an individual examination for soundness.

6.4.5 Retests If during inspection, a test does not give the required results, additional tests, unless otherwise agreed, may be carried out as follows:

a) **Tensile test** Procedures defined in **8.3.4.3.2** "Non-sequential tests" of **ISO 404** : 1992 shall apply.

b) **Impact test** The assessment of impact test results shall be made following a sequential method as described in **8.4.3.2** of **ISO 404** : 1992 and if retests are necessary, they shall be carried out according to **8.3.4.3.3** of **ISO 404**.

6.5 Inspection documents The type of inspection documents required shall be chosen among those defined in **ISO 10474** and specified in the order.

In any case, this inspection document shall state the manufacturer's results for the ladle analysis of all chemical elements specified for the steel grade concerned.

7 Sorting and reprocessing The requirements of clause **9** of **ISO 404** : 1992 shall apply.

8 Non-destructive tests If the purchaser requires non-destructive tests to check the soundness of the products by means of ultrasonic, magnetic or liquid penetrant examination methods, these tests shall be agreed upon at the time of enquiry and order. This agreement shall include details of the test methods and interpretation of results.

9 Marking Unless otherwise agreed at the time of ordering, products other than those of E 185 shall be legibly marked with the followings.

a) the identification symbols for the grade and quality of the steel;

b) brand of the manufacturer;

c) if necessary, symbols, letters or numbers which allow the inspection document, test samples and products to be identified.

In the case of products of small unit mass which are consigned in bundles, the above information may be marked on a tag securely attached to each bundle (or it may be marked on the upper plate).

10 Order The order shall specify.

— if a particular steel making process is required (**4.1**)

— if the purchaser wishes to be informed of the steel making process (the choice of process being left to the manufacturer) (**4.1**)

— if a particular delivery condition is required (**4.2**)

— the type of quality D required (**4.2.2**)

— if repair by welding is not permitted [**4.3.3 b**)]

— if product analysis is required (**5.1.2**) and the number of samples required [**6.4.3 a**)]

— if impact tests for quality B are required (**6.1**)

— if impact tests for each rolled product are required for quality D [**6.2.4 b**)]

— if impact tests for products less than 12 mm thick are required [**6.4.2 a**)]

— if retests are not permitted (**6.4.5**)

— the type of inspection document required (**6.5**)

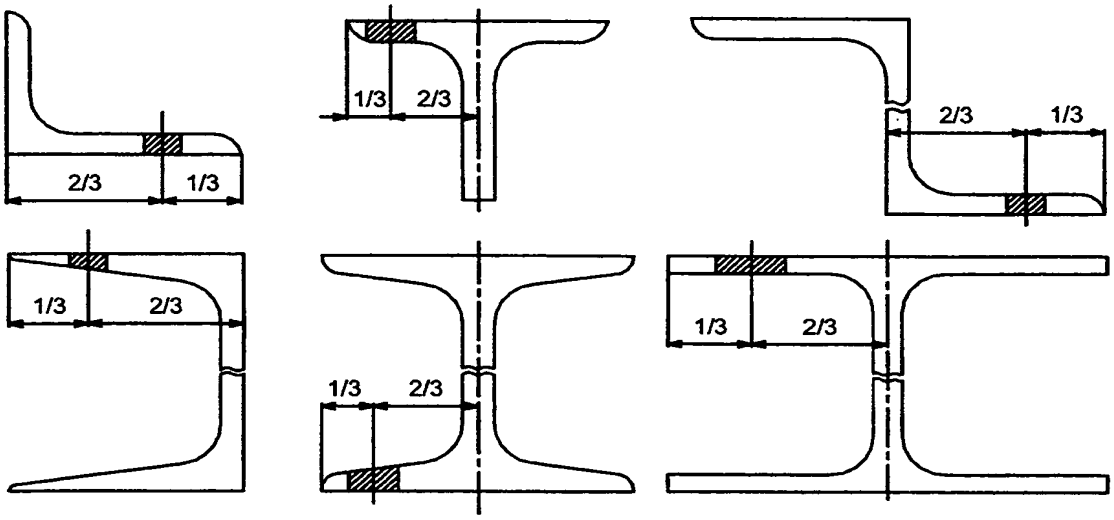
— if non-destructive tests are required (**8**)

— if other types of marking are required (**9**)

Points that are not specified shall not be taken into account by the manufacture

Annex A (normative)
Position and orientation of test pieces

Introduction This annex is the Japanese Industrial Standard prepared based on **ISO 630** *Structural steels—Plates, wide flats, bars, sections and profiles* published in 1995 as the second edition without modifying its technical content.



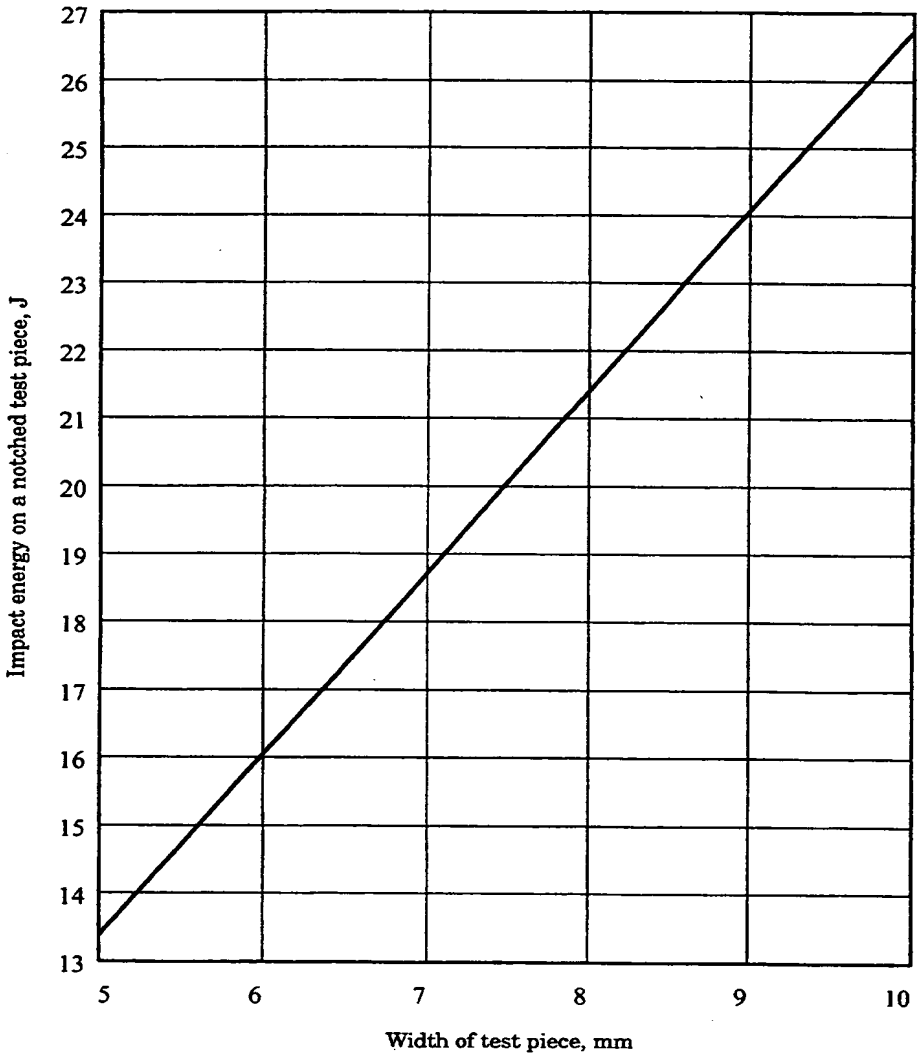
Remarks : Refer to **6.4.2** [for the impact test, see also **6.4.2 a)**].

Annex A Figure A.1 Position and orientation of test pieces

Annex B (normative)

Energy values for impact test pieces of reduced size

Introduction This annex is the Japanese Industrial Standard prepared based on annex B (normative) to **ISO 630** *Structural steels—Plates, wide flats, bars, sections and profiles* published in 1995 as the second edition without modifying its technical content.



Annex B Figure B.1 Minimum impact energy values for test pieces with a width between 5 mm and 10 mm

Annex C (informative)

List of International Standards on tolerances for steel products

Introduction This annex is the Japanese Industrial Standard prepared based on **ISO 630** *Structural steels—Plates, wide flats, bars, sections and profiles* published in 1995 as the second edition without modifying its technical content.

This annex shall not a parts of this Standard, provided only a supplement for the items related to the provision of the body of this Standard.

ISO 657-5 : 1976	*Hot-rolled steel sections—Part 5 : Equal-leg angles and unequal-leg angles—Tolerances for metric and inch series*
ISO 657-13 : 1981	*Hot-rolled steel sections—Part 13 : Tolerances on sloping flange beam, column and channel sections*

Information : **ISO 657-13** : 1981 was withdrawn in 2002.

ISO 657-18 : 1980	*Hot-rolled steel sections—Part 18 : L sections for shipbuilding (metric series)—Dimensions, sectional properties and tolerances*
ISO 657-19 : 1980	*Hot-rolled steel sections—Part 19 : Bulb fats (metric series)—Dimensions, sectional properties and tolerances*
ISO 1035-4 : 1982	*Hot-rolled steel bars—Part 4 : Tolerances*
ISO 7452 : 1984	*Hot-rolled structural steel plates—Tolerances on dimensions and shape*

Annex D (informative)
Notes on weldability

Introduction This annex is the Japanese Industrial Standard prepared based on annex D to **ISO 630** *Structural steels—Plates, wide flats, bars, sections and profiles* published in 1995 as the second edition without modifying its technical content.

This annex shall not a parts of this Standard, provided only a supplement for the items related to the provision of the body of this Standard.

The steels specified in this annex do not have unlimited suitability for the various welding processes, since the behaviour of a steel during and after welding depends not only on the material but also on the dimensions and shape, as well as on the manufacture and service conditions of the components.

There is no information concerning the weldability of the grade E 185 and quality A available, as no requirements are specified concerning the chemical composition or in a satisfactory way in terms of weldability.

Steels of qualities B, C and D are generally suitable for all welding processes.

The weldability increases from quality B to D. For grade E 235 B, killed steels (NE or GF) are preferable to steels without specified deoxidation, particularly if segregation zones could be encountered during welding.

With increasing product thickness and increasing strength level, the main risk is the occurrence of cold cracking in the welded zone.

Cold cracking is caused by a combination of the following factors:

— the amount of diffusible hydrogen in the weld metal;

— a brittle structure of the heat-affected zone;

— a significant concentration of tensile stress in the welded joint.

Annex 3 (informative)

Comparison table between JIS and corresponding International Standard

JIS G 3106:2004 *Rolled steels for welded structure*					**ISO 630**:1995 *Structural steels—Plates, wide flats, bars, sections and profiles*		
(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: annex Indication method: dotted underlines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
1	Scope Steel plate, steel strip in coil, section and flat	**ISO 630**	1	Scope Steel plates, wide strip in coils, wide flats, bars, section and profiles	MOD/ deletion	**JIS** does not include bars.	Bars are specified in other **JIS** which can be applied as needed.
2	Normative references **JIS G 0404, JIS G 0415, JIS G 0416** and others		2	Normative references **ISO 148-1, ISO 377** and others	MOD/ alteration	Some **JIS** have no corresponding International Standards.	International Standards will be cited after the harmonization of cited standards.
3	Grade and designation SM400A, B, C SM490A, B, C SM490YA, YB SM520C SM570		5	Characteristics of grades and qualities E185 E235 E275 E355	NEQ	Designation of grade is determined based on the tensile strength in **JIS** and on the yield point in **ISO**.	

(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: annex Indication method: dotted underlines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
4	Chemical composition Five elements (C, Si, Mn, P, S) are specified. Alloying elements may be added as necessary.		5	Characteristics of grades and qualities Five elements (C, Si, Mn, P, S) are specified. Grades are also provided to which elements which produce a fine-grained structure are added.	NEQ	**ISO**'s specification is less strict especially in P and S.	We will propose the value of **JIS**.
5	Carbon equivalent or chemical composition on sensitivity of welding crack				NEQ	Not specified in **ISO**.	We will propose to specify them.
6	Mechanical property		6	Inspection and testing		—	
6.1	Yield point or proof stress, tensile strength and elongation		6.2.4	Tensile test Yield stress, tensile strength and elongation are specified.	NEQ	**JIS** and **ISO** differ in the balance of yield point and tensile strength (difference of design concept).	We will propose the grade of **JIS** to **ISO**.
6.2	Charpy absorption energy B grade: 0 °C, 27 J min. C grade: 0 °C, 47 J min. SM570: −5 °C, 47 J min.		6.4.2	Impact test Test temperature: −20, 0, +20 27 J min.	MOD/ alteration	**JIS** and **ISO** differ in the specified values of temperature and energy.	
7	7 Shape, dimension, mass and the tolerance thereof **JIS G 3192, JIS G 3193** and **JIS G 3194** are cited.				NEQ	No items in **ISO**.	

(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: annex Indication method: dotted underlines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
8	Appearance Appearances in **JIS G 3192**, **JIS G 3193** and **JIS G 3194** are cited.		4.3	Surface appearance—Defects **ISO 7788** is cited.	NEQ	**JIS** and **ISO** differ in the cited standards.	We will harmonize the cited standards.
9	Heat treatment and symbol Normalizing, quench-hardening and tempering, tempering and thermomechanical control are specified.		4.2	Delivery condition As-rolled condition. Other conditions shall be agreed upon. Symbols are not specified.	NEQ	**ISO** has no specification of symbols.	
10	Tests						
10.1	Chemical analysis Clause **8** of **JIS G 0404** is cited. For analytical methods, methods of each **JIS** are cited.		6.4.3	Chemical analysis In case the corresponding International Standard does not exist, the method to be used shall be agreed between the purchaser and the supplier.	MOD/ alteration	**JIS** cites **JIS** for the analytical method.	We will harmonize the analytical methods of **JIS** to **ISO**.
10.2	Analytical method Clause **9** of **JIS G 0404** is cited. In case of over 50 t, 2 pieces. For the sampling position of test pieces, **JIS G 0416** is cited.		6.2 Annex A	Test unit 50 t or part thereof Sampling position of test pieces	NEQ	**JIS** and **ISO** differ in the test number when the test lot exceeds 100 t. Sampling position of test pieces has been harmonized.	We will propose **JIS**.

(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause Location of deviation: annex Indication method: dotted underlines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
11	Inspection For general matters and reinspection, **JIS G 0404** is cited.		6.4.5	Retests **ISO 404** is cited.	IDT		
12	Marking a) Symbol of grade b) Heat number of inspection number c) Dimension d) Quantity or mass of each bundle e) Manufacturer's name or identifying brand		9	Marking a) Grade and quality of the steel b) Brand of the manufacturer c) Identification number as needed	MOD/ addition	**JIS** has more specified items than **ISO**.	We will propose **JIS**.
13	Report **JIS G 0404** and **JIS G 0415** are cited.		6.5	Inspection documents **ISO 10474** is cited.	MOD/ alteration	**JIS** has more detailed contents than **ISO**.	We will propose **JIS**.
Annex 1	(normative) Sampling position of the test piece		Annex A	Position and orientation of test pieces	NEQ	**JIS** is specified with the applicable date and will be harmonized to **ISO** in future.	
Annex 2	(normative) Structural steels—Plates, wide flats, bars, section and profiles		text	(normative) Structural steels—Plates, wide flats, bars, section and profiles	IDT		

(I) Requirements in **JIS**		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between **JIS** and the International Standard by clause Location of deviation: annex Indication method: dotted underlines		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
Annex A	(normative) Position and orientation of test pieces		Annex A	(normative) Position and orientation of test pieces	IDT		
Annex B	(normative) Energy values for impact test pieces of reduced size		Annex B	(normative) Energy values for impact test pieces of reduced size	IDT		
Annex C	(informative) List of International Standards on tolerances for steel products		Annex C	(informative) List of International Standards on tolerances for steel products	IDT		
Annex D	(informative) Notes on weldability		Annex D	(informative) Notes on weldability	IDT		

Designated degree of correspondence between **JIS** and International Standard: MOD

Remarks 1 Symbols in sub-columns of classification by clause in the above table indicate as follows:

— IDT: Identical in technical contents.

— MOD/deletion: Deletes specification item(s) or content(s) of International Standard.

— MOD/addition: Adds specification item(s) or content(s) not included in International Standard.

— MOD/alteration: Alters the specification content(s) included in International Standard.

— NEQ: Not equivalent.

2 Symbol in column of designated degree of correspondence between **JIS** and International Standard in the above table indicates as follows:

— MOD: Modifies International Standard.

Errata for JIS (English edition) are printed in *Standardization Journal*, published monthly by the Japanese Standards Association, and also provided to subscribers of JIS (English edition) in *Monthly Information*.

Errata will be provided upon request, please contact:
Standardization Promotion Department, Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN
TEL. 03-3583-8002 FAX. 03-3583-0462

JIS

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS Z 3312 : 1999

MAG welding solid wires for mild steel and high strength steel

ICS 25.160.20

Descriptors : low-carbon steel, high-tensile steels, gas-shielded welding, filler wire, steels

Reference number : **JIS Z 3312 : 1999 (E)**

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at the Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently **JIS Z 3312** : 1993 is replaced with **JIS Z 3312** : 1999.

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

In this revision, **JIS Z 3200** is used as a normative reference following the establishment of **JIS Z 3200** wherein dimensions, tolerances, the condition of products, marking and packaging are specified.

Date of Establishment: 1974-03-01

Date of Revision: 1999-11-20

Date of Public Notice in Official Gazette: 1999-11-22

Investigated by: Japanese Industrial Standards Committee
Divisional Council on Welding

JIS Z 3312:1999, First English edition published in 2002-03

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

In the event of any doubts arising as to the contents, the original JIS is to be the final authority.

MAG welding solid wires for mild steel and high strength steel

1 Scope This Japanese Industrial Standard specifies the solid wires to be used for MAG welding of mild steel and high strength steels having tensile strength levels of 490 N/mm², 520 N/mm², 540 N/mm² and 590 N/mm², respectively (hereafter referred to as "wires").

2 Normative references The standards given in Attached Table 1 contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent standards shall be applied.

3 Classification The wires shall be classified according to the shielding gas, applicable main steel grade and chemical composition thereof as given in Table 1.

Table 1 Classification of wires

Classification	Shielding gas	Applicable main steel grade
YGW11 YGW12 YGW13 YGW14	Carbon dioxide (CO_2)	Mild steel and high strength steel having a tensile strength level of 490 N/mm²
YGW15 YGW16 YGW17	Mixed gas composed of 80 % of argon and 20 % of carbon dioxide (80 Ar-20 CO_2)	
YGW18	Carbon dioxide (CO_2)	High strength steels having tensile strength levels of 490 N/mm², 520 N/mm² and 540 N/mm²
YGW19	Mixed gas composed of 80 % of argon and 20 % of carbon dioxide (80 Ar-20 CO_2)	
YGW21 YGW22	Carbon dioxide (CO_2)	High strength steel having a tensile strength level of 590 N/mm²
YGW23 YGW24	Mixed gas composed of 80 % of argon and 20 % of carbon dioxide gas (80 Ar-20 CO_2)	

Remarks : The symbol used for identifying the type of the wires shall be as given in the following example:

Example : Y GW 11

- 11 — Shielding gas, applicable main steel grade and chemical composition of the wire
- GW — For MAG welding
- Y — Welding wire

4 Quality

4.1 Appearance The appearance of the wires shall be in accordance with **3** of **JIS Z 3200**.

4.2 Chemical composition As to the chemical composition of wires, the product shall be tested in accordance with **7.1** and the results shall conform to Table 2.

Alloy elements other than those given in Table 2 may be added, if necessary.

Table 2 Chemical composition of wires

Unit : %

Classification	Chemical composition										
	C	Si	Mn	P	S	Cu(1)	Ni	Cr	Mo	Al	Ti+Zr
YGW11	0.15 max.	0.55 to 1.10	1.40 to 1.90	0.030 max.	0.030 max.	0.50 max.	—	—	—	0.10 max.	0.30 max.
YGW12	0.15 max.	0.55 to 1.10	1.25 to 1.90	0.030 max.	0.030 max.	0.50 max.	—	—	—	—	—
YGW13	0.15 max.	0.55 to 1.10	1.35 to 1.90	0.030 max.	0.030 max.	0.50 max.	—	—	—	0.10 to 0.50	0.30 max.
YGW14	0.15 max.	—	—	0.030 max.	0.030 max.	0.50 max.	—	—	—	—	—
YGW15	0.15 max.	0.40 to 1.00	1.00 to 1.60	0.030 max.	0.030 max.	0.50 max.	—	—	—	0.10 max.	0.13 max.
YGW16	0.15 max.	0.40 to 1.00	0.85 to 1.60	0.030 max.	0.030 max.	0.50 max.	—	—	—	—	—
YGW17	0.15 max.	—	—	0.030 max.	0.030 max.	0.50 max.	—	—	—	—	—
YGW18	0.15 max.	0.55 to 1.10	1.40 to 2.60	0.030 max.	0.030 max.	0.50 max.	—	—	0.40 max.	0.10 max.	0.30 max.
YGW19	0.15 max.	0.40 to 1.00	1.40 to 2.00	0.030 max.	0.030 max.	0.50 max.	—	—	0.40 max.	0.10 max.	0.30 max.
YGW21	0.15 max.	0.50 to 1.10	1.30 to 2.60	0.025 max.	0.025 max.	0.50 max.	—	—	0.60 max.	0.10 max.	0.30 max.
YGW22	0.15 max.	—	—	0.025 max.	0.025 max.	0.50 max.	—	—	—	—	—
YGW23	0.15 max.	0.30 to 1.00	0.90 to 2.30	0.025 max.	0.025 max.	0.50 max.	1.80 max.	0.70 max.	0.65 max.	—	0.20 max.
YGW24	0.15 max.	—	—	0.025 max.	0.025 max.	0.50 max.	—	—	—	—	—

Note (1) When the wires are subjected to copper-plating, copper for the coating is included.

4.3 Mechanical properties The tensile strength, yield point or 0.2 % proof stress, elongation and Charpy absorbed energy of the deposited metal shall be tested in accordance with **7.2**, and they shall conform to Table 3.

With this respect, the kind of shielding gas to be used shall be in accordance with Table 1. However, in the case where other kinds of shielding gas than those listed in Table 1 are used, it shall be agreed upon between the purchaser and the supplier.

Table 3 Mechanical properties of deposited metal

Wire	Tensile test			Impact test	
	Tensile strength N/mm²	Yield point or 0.2 % proof stress (2) N/mm²	Elongation %	Test temperature °C	Charpy absorbed energy J
YGW11	490 min.	390 min.	22 min.	0	47 min.
YGW12					27 min.
YGW13					
YGW14	420 min.	345 min.			
YGW15	490 min.	390 min.		−20	47 min.
YGW16					27 min.
YGW17	420 min.	345 min.			
YGW18	540 min.	430 min.		0	47 min.
YGW19				−20	47 min.
YGW21	570 min.	490 min.	19 min.	−5	47 min.
YGW22					27 min.
YGW23				−20	47 min.
YGW24					27 min.

Note (2) Whether the measured value repesents the yield point or 0.2 % proof stress shall be stated clearly in the test records or the like.

5 Dimensions and tolerances The diameter and tolerances of the wires shall be in accordance with **2** of **JIS Z 3200**. Representative diameters of wires are given in Table 4.

Table 4 Representative diameter of wires

Unit : mm

Diameter	0.6, 0.8, 0.9, 1.0, 1.2, 1.4, 1.6, 2.0

6 Condition of products The condition of the products shall be specified in **3** of **JIS Z 3200**.

7 Tests

7.1 Chemical analysis of wires The chemical analysis of the wires shall be as follows:

a) The diameter of the wires to be used for chemical analysis shall be 1.2 mm or its near size for each type of the wires.

b) The chemical analysis of the wires shall be in accordance with any one of the following standards:

JIS G 1201, JIS G 1211, JIS G 1212, JIS G 1213, JIS G 1214, JIS G 1215, JIS G 1216, JIS G 1217, JIS G 1218, JIS G 1219, JIS G 1223, JIS G 1224, JIS G 1232, JIS G 1253, JIS G 1256, JIS G 1257, JIS G 1258

7.2 Tensile test and impact test of deposited metal The tensile test and impact test of the deposited metal shall be as follows.

However, other procedures than those given in a) to g) shall conform to **JIS Z 3111**.

a) The diameter of the wires to be tested shall be 1.2 mm or its near size for each type of the wires.

b) For current polarity, the d.c. wire positive shall be used.

c) As to the shielding gas to be used for the test, carbon dioxide gas of class 3 of **JIS K 1106**, mixed gas composed of 80 % of argon gas and 20 % of carbon dioxide gas, or the gases equivalent to those in quality shall be used. Argon in the mixed gas shall be specified in **JIS K 1105**. Shielding gases other than those shall be agreed upon between the purchaser and the supplier.

d) The test plate to be used in the test shall be as specified in Table 5. However, when the test plate as indicated in the column of "with buttering" is used, buttering of 3 mm or over in thickness and with two layers or more by the wire to be tested or the wires equivalent thereto shall be conducted on the surface of the groove and the backing metal.

With this respect, rolled steels having comparable chemical composition and mechanical properties to the test plate given in Table 5 may be used.

Table 5 Test plates

Wire	Test plate	
	Without buttering	With buttering
YGW11 YGW12 YGW13 YGW15 YGW16	SM490A to C in **JIS G 3106** or SN490B to C in **JIS G 3136**	SS400 in **JIS G 3101**, SM400A to C in **JIS G 3106** or SN400A to C in **JIS G 3136**
YGW14 YGW17	SS400 in **JIS G 3101** or SM400A to C in **JIS G 3106**	—
YGW18 YGW19	SM520B to C in **JIS G 3106**	SS400 or SS490 in **JIS G 3101**, SM400A to C or SM490A to C in **JIS G 3106**, or SN400A to C or SN490B to C in **JIS G 3136**
YGW21 YGW22 YGW23 YGW24	SM570 in **JIS G 3106**	SS400 or SS490 in **JIS G 3101**, SM400A to C, SM490A to C or SM520B to C in **JIS G 3106**, or SN400A to C or SN490B to C in **JIS G 3136**

e) The thickness of the test plate shall be 20 mm.

f) The preheating and interpass temperatures of the test plate shall be as given in Table 6.

Further, in the case of no preheating, continuous welding shall be executed until reaching a specific interpass temperature.

g) The number of layers shall be 5 to 8 layers, and the number of passes for each layer shall be one pass to two passes for the first layer, and two to three passes on and after the second layer.

Table 6 Preheating and interpass temperatures

Unit : °C

Wire	Preheating temperature	Interpass temperature
YGW11, YGW12, YGW13, YGW14, YGW15, YGW16, YGW17, YGW18, YGW19	None	150±15
YGW21, YGW22, YGW23, YGW24	100±10	150±15

8 Inspection The inspection shall be as follows:

a) As to wires, the appearance, dimensions and condition of the products shall conform to the requirements specified in **4.1**, **5** and **6** respectively.

b) As to wires, the results on chemical analysis and tensile and impact test of the deposited metal shall conform to the requirements specified in **4.2** and **4.3** respectively.

In the case where either of the test results above-mentioned does not meet the requirements, retest on the relevant item may be carried out only once. In this case, the results shall conform to the requirements.

9 Packaging The packaging shall be as specified in **5** of **JIS Z 3200**.

10 Designation of products The products shall be designated by type, diameter and mass of the wire.

Example : YGW11 – 1.6 – 20

Type of wire Diameter Mass

11 Marking The marking shall be as specified in **4** of **JIS Z 3200**.

Attached Table 1 Normative references

JIS G 1201	*General rules for chemical analysis of iron and steel*
JIS G 1211	*Iron and steel—Methods for determination of carbon content*
JIS G 1212	*Iron and steel—Methods for determination of silicon content*
JIS G 1213	*Methods for determination of manganese in iron and steel*
JIS G 1214	*Iron and steel—Methods for determination of phosphorus content*
JIS G 1215	*Iron and steel—Methods for determination of sulfur content*
JIS G 1216	*Iron and steel—Methods for determination of nickel content*
JIS G 1217	*Methods for determination of chromium in iron and steel*
JIS G 1218	*Iron and steel—Methods for determination of molybdenum content*
JIS G 1219	*Iron and steel—Methods for determination of copper content*
JIS G 1223	*Iron and steel—Methods for determination of titanium content*
JIS G 1224	*Methods for determination of aluminium in iron and steel*
JIS G 1232	*Methods for determination of zirconium in steel*
JIS G 1253	*Iron and steel—Method for spark discharge atomic emission spectrometric analysis*
JIS G 1256	*Iron and steel—Method for X-ray fluorescence spectrometric analysis*
JIS G 1257	*Iron and steel—Methods for atomic absorption spectrometric analysis*
JIS G 1258	*Iron and steel—Methods for inductively coupled plasma atomic emission spectrometry*
JIS G 3101	*Rolled steels for general structure*
JIS G 3106	*Rolled steels for welded structure*
JIS G 3136	*Rolled steels for building structure*
JIS K 1105	*Argon*
JIS K 1106	*Liquid carbon dioxide*
JIS Z 3111	*Methods of tension and impact tests for deposited metal*
JIS Z 3200	*Welding consumables—Technical delivery conditions for welding filler metals—Type of product, dimensions, tolerances and marking*

Errata for JIS (English edition) are printed in *Standardization Journal*, published monthly by the Japanese Standards Association, and also provided to subscribers of JIS (English edition) in *Monthly Information*.

Errata will be provided upon request, please contact:

Standardization Promotion Department, Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN
TEL. 03-3583-8002 FAX. 03-3583-0462

100% Recycled paper

2007 – 01 – 22 Printed by JSA